Wearable health technology design

Wearable Health Technology Design: *A Humanist Accessory Approach*

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This article presents the "accessory approach," conceived as a holistic form of body adornment, not only associated with fashion, but also as a design approach which includes a wearer's physical, psychological and social preferences. We propose this as a humanistic design philosophy which may inform the design of future wearable health technology, in contrast to increasing trends toward the medicalization and quantification of people's whole lives. At the same time, there is a pragmatic case to be made for more human-centred approaches to the design of assistive technologies for the body, which are frequently rejected by end users due to poor cultural (as well as physical) fit. We examine the potential socio-phenomenological framework offered by the accessory as a relational category of both expressive and functional objects. Using Cunningham's framework of narrative contemporary jewellery, we analyse three projects, and show how the accessory can function as a complex platform to support relations between maker, wearer and viewer. Finally, we relate this approach to the debate in interactive wearable design regarding the visibility of technology on the body, and propose a shift from designing wearable health technologies with minimal "social weight," to providing a relational platform capable of supporting what we have termed "social agility."

Keywords **–** Accessory Design, Accessory Approach, Body Adornment, Persons with Diverse Needs, Wearable Health Technology.

Relevance to Design Practice **–** This article provides insight into ways of designing future wearable health technologies through explicitly addressing the physical, psychological, and social body. This supports design for different conceptions of wellbeing, allowing people, including those with diverse needs, to flourish. It provides a humanist accessory approach, which contrasts with deterministic, medicalized practices.

Citation: Møller, T., & Kettley, S. (2017). Wearable health technology design: A humanist accessory approach. *International Journal of Design, 11*(3), 35-49.

Introduction

There is an increasing shift of care from clinical settings into "patients' hands and homes," which demands that designers be "more reflective practitioners to ensure that the new health technologies we design are actually fit for *everyday life*" (Fitzpatrick, 2011, p. 121). The design space for medical technologies is radically altered by the fundamental changes to notions of patient, clinician, care and home put in motion by this shift, and nowhere is the power of the patient more evident than in the scale of rejection of body-worn devices.

Studies have shown that there is a high rate of rejection of *wearable and assistive technologies* by persons with diverse needs (between 50% and 56%), and that 15% of such objects are never used (Hocking, 1999; Ledger & McCaffrey, 2014). This is a critical situation, as the demand for remote healthcare monitoring is increasing due to reduced health system resources, an ageing population and an increase in individuals living with lifelong conditions (Deen, 2015). However, the emphasis on clinical needs in the disability and biomedical research literature too often excludes the wearer's physical, psychological and social preferences in the design of *wearable health technology* (Bush, 2015). Pape, Kim, and Weiner (2002), and Bergmann and McGregor (2011), hold that the opportunity (or lack of it) to create personal meanings influences the successful integration of assistive technologies into an individual's lifeworld, and that holistic end-user preferences therefore need to be taken into account to be able to design devices that will be accepted. However, there is a corresponding concern within the field of medical ethics that medicalization is expanding to define a person's "whole dynamic life process… in biomedical technoscientific terms" (Vogt, Hofmann, & Getz, 2016, p. 310); the "virtuous circle" of the Quantified Self movement (Wicks & Little, 2013) has been questioned for its questionable blurring of personal and health data, basis in often inaccurate sensor measurements, and unmanageable permissions considerations (for developers as well as users), all with potential implications for the costs of care (Shao, Kuk, Terrell, & Chen, 2014; Naughton, 2016). Further, we have experienced the empowerment narrative in healthcare (Fitzpatrick, 2011) as instrumental, based on a neoclassical economic agenda, and an atomistic understanding of personalisation rather than a humanistic, relational approach (Kettley, Kettley, & Lucas, 2017; Waerness, 2006). In worst-case scenarios, the person receiving care can be separated conceptually and practically from their personal care networks by services; at a more prosaic level, individuals are increasingly expected to make good life decisions, not only to

Received December 19, 2016; **Accepted** July 6, 2017; **Published** December 31, 2017.

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take responsibility for managing long-term health conditions, as pressure increases on health service providers to meet demands, but also in a consumer marketplace of profit-oriented private care provision. We therefore see high levels of rejection as a symptom of a (political) normative medicalized design approach, and in an effort to alleviate these, we investigate (political) humanistic approaches in which a person is not medicalized, nor defined by others in terms of their experiences of (mental) health, but is encountered first and foremost as an individual who is "allowed to dream" (Durieux, 1921, as cited in Lehman, 2000, p. 359; Joseph, 2010). In this approach, the empowerment agenda is also called into question, as power is never taken away from individuals in the first place (Rogers, 1978; Sharma, 2008). Further, it requires the designer to think beyond the "killer app" (Abowd & Mynatt, 2000) and the end-user application (McCann et al., 2005) as goals in themselves, to create relational contexts in which individuals can thrive (Rogers, 2004).

In 1991 Weiser foresaw that the most profound technologies would weave themselves into the fabric of everyday life. His vision has led to the idea that the computer, and the wearable, should function as an invisible aid integrated "seamlessly" into the everyday (Norman, 1998). In wearables design, this led to an early emphasis on the reduction of "*social weight*," defined as "social repercussions in the form of unwanted attention or negative responses that an individual may receive when 'inappropriately' dressed" (Dunne et al., 2014, p. 27). This reduction in social weight has typically been achieved by making technology on the body less visible, and ideally completely hidden, in line with the *disappearing computer* narrative (Norman, 1998). The initial assumption was that technology on the body should not be apparent to others as technology, and that in use, it should disappear phenomenologically for the wearer (Weiser, 1991). However, the notion of appropriate dress is also problematic, or perhaps more positively, it opens up an opportunity for design which has still to be fully explored. We also note that while Fitzpatrick's (2011) keynote covered design for integration and active participation, in which aspects such as contested spaces, routines, relationships and collaborative meaning-making become important, it stopped short of the wearable and the extra considerations that designing for the body entails (Gemperle, Kasabach, Stivoric, Bauer, & Martin, 1998).

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We suggest that when wearable health technology design focuses on medical need, it glosses over the individual human need to dynamically manage social identity (White, 2008). Through such glossing over, persons with diverse needs themselves become defined as controllable medical systems. A more deliberately empathic relationship in addressing dynamic user needs could focus on active "valuing" rather than static "values" (Cooper & McLeod, 2011), and could better include beauty, desirability, and alignment as aspects of fluid identity management (Goffman, 1990; Wallace, 2007). Wearables are starting to diversify to include a wide range of expressive opportunity; such an approach would offer individuals contexts for playful explorations of identity within what Ryan (2014) has called a wearable "paradise."

From the wearer's perspective, we are therefore interested in both the phenomenological experience of the wearer in the *dress act* (Entwistle, 2015), and the wearer's reconfiguration of the meaning of the object as authored by the maker; they too play a role in distributed construction of a narrative through the object. Only by actively considering these interlinked aspects of experience with *accessories* can we hope to challenge the currently short lifespans and limited aesthetics of health wearables still manufactured as gadgets using silicone, plastic and alphanumeric screens (Silina & Haddadi, 2015).

To explore these dimensions, the article firstly discusses the notion of the accessory as a platform, within which systems, applications, and interventions can be designed; and we link this figuration with an extended view of the user as social actor. We go on to consider the semiotic and phenomenological terms in fashion theory, before outlining Cunningham's (2005a, 2005b) maker–wearer–viewer model through these two lenses. Cunningham's model is then used to analyse three projects: *Intimacy in Accessories* (2016), *An Internet of Soft Things* (2016), and the *Welfare Design Project* (2016). The model is finally opened up to students for reflexive reinterpretation and discussion.

The Accessory as a Platform: *Conceptual and Technical*

The accessory by definition does not exist by itself, but in relation to another object or other objects. Moreover, the type of relationship is quite specific: it is an ontological hierarchy between a principal and its accessory, in which the accessory "derives its value from the principal" (Oppy, 2015). It is a mutually beneficial relationship illustrated by the *master and slave* metaphor. In the context of fashion (rather than of law or theology), accessories are easily imagined: they are sometimes practically useful, as in umbrellas and glasses, and sometimes decorative, as in jewellery. Often, and especially in the case of menswear, they can have a use function, but also carry *semiotic meaning*, such as in the watch, or tie. They contribute to a system of fashion in relation to garments (as the principal), through "bricolage," or a layering of semiotic meaning to create a whole, personally enacted "expression" (Woodward, 2007). If fashion is a semiotic system—a language (Lurie, 2000),

with each word in an outfit contributing to a coherent utterance—then we might say the accessory plays the role of the *modifier*, changing the meaning of the whole (Kerre & de Cock, 1999).

The master–slave hierarchy, and even the modifier, can also be found in the organization of computer network systems, and the fuzzy logics that drive them (Kumar, 2012; Rouse, 2016). But this simplistic model is being replaced as *Ubiquitous Computing* and the *Internet of Things* (IoT) mature; there is a transition from one-to-one models and personal systems in human–computer interaction (HCI) to complex socio-technical systems defined by dynamic interconnecting networks of multiple actors, including sensor-enabled interfaces, embedded processing, distributed output devices, people, and intelligent "things." Lindqvist (2015) and Woodward (2007) have developed relational approaches in the fashion literature, while in relational philosophy, identity is said to emerge not from a priori individuals, but from relations themselves (Latour, 2014; Thayer-Bacon, 2003). We thus see parallels between the accessory as a platform for dynamic relational identity enactment, and the increasingly distributed topologies of Ubiquitous Computing and the IoT, in which the modifier can come to define the whole (Durschei & Neri-Belkaïd, 2005). As Marchetti (2005) says:

> The accessory is the ideal vehicle for the movement of the post-modern identity from the center to the periphery… it embodies exchange, that is, the thing with which we part to give to others in a reciprocal arrangement… which supports the social circulation of identity values. (p. 61)

Body Adornment and Semiotic Display

Anthropologists argue that there is a universal human propensity to adorn, and that we have been adorning our bodies with decorative objects for as long as there have been human beings (Polhemus, 2005). This position is widely accepted by writers on dress and fashion (Roach-Higgins & Eicher, 1992; Entwistle, 2015). Agreeing with Polhemus, we recognize the semiotic role of body adornment: "Objects worn or kept near the body (from feather headdresses, masks, jewellery, a watch to a mobile phone) have always and will always be chosen because of what they 'say' about the wearer – they are visual adjectives" (p. 30). This suggests that accessories play a functional role in expressive acts of "speaking" in line with communication theory; however, this view has been critiqued in the fashion literature as an over-simplistic model in which the wearer's intentions are well defined and communicated clearly (Lurie, 2000; Barnard, 2007). Rather, an individual's expressive dress acts may well "speak," but what is said only becomes meaningful because of identities constituted in fluid relations with other people (Goffman, 1990; Roach-Higgins & Eicher, 1992). Further, there are acts of deliberate expression, and those that are "given off" (Goffman, 1990, p. 16), as well as changes over time and ownership. Decisions are made at the point of purchase concerning comfort and the potential for expression, but these factors also continue to figure in everyday moments of dressing and re-dressing, as new combinations of garments and adornment are played with to refine and redefine identity in relation with the world.

Lived Experience and the Phenomenological Wearable

We are concerned that medical accessories have the ability to deny the body and the self, as existential bodily awareness, or "corporeal awareness" (Shusterman, 2012, p. 54), has become appropriated by the medical industry, and that it is no longer the right of the person to attend to themselves, as they become "largely invisible and passive" in the clinical environment (Fitzpatrick, 2011, p. 124). Western medicine's understanding of the body and the person have been critiqued in ethnographic, philosophical, and political analyses (Illich, 1976; Mol, 2003; Vogt, Hofmann, & Getz, 2016), but despite the World Health Organisation's (2010) recognition that "robust scientific evidence is not enough to guarantee that a novel medical technique will disseminate into widespread use" (p. 5), the body and lived experience continue to be written out of the clinical discourse through an institutional mistrust of qualitative methodologies (Greenhalgh et al., 2016).

We welcome the increase in participatory and co-design practices in wearables development: in 2005, McCann et al. pointed out that fashion designers rarely "have 'hands on' involvement in prototype garment manufacture," and that wearables demand just such a hands-on approach to achieve appropriate cut and fit (p. 76). More than a decade later, *User-Centred Design* (UCD) is still a novelty in most fashion and textile design practice, even as its limitations are being examined in design anthropology (Bezaitis & Robinson, 2010). Its limitations for designing with mental health care services have been explored by Kettley, Kettley, & Lucas (2017). In digital jewellery, different forms of participatory and user-centred design have been described by Kettley (2007), Bush (2015), and Wallace (2007), while in wearables for active ageing, McCann (2016) described the co-design process methodology as evolving from "designing for users to designing with users… emancipating people by making them active contributors rather than passive recipients" (p. 241).

As part of this emancipation, there has been a rise in interest in embodied design methodologies (Wilde & Underwood, 2015; Toeters, Bhömer, Bottenberg, Tomico, & Brinks, 2013; Tognazzi-Drake, 2013), which seek to address the whole body and felt experience of the person, rather than treating them only as a rational consumer and decision maker. These approaches go beyond cognitive and behavioural models of the person, towards the humanistic (Kettley et al., 2017). Entwistle (2015) provides a valuable insight into ways of thinking about the body and identity in the context of dress. She outlines two disciplines of thought: *structuralism*, in which the body is "socially constituted, always situated in culture" (p. 34), and *phenomenology*, which "offers the potential to understand dress as an embodied experience" (p. 35). Entwistle's project is to bring these theoretical positions together as "situated practice" (p. 53): "The experience of dress is a subjective act of attending to one's body and making the body an object of consciousness, and is also an act of attention with the body" (p. 49).

To explore the accessory in light of these theories, we borrow a model from contemporary narrative jewellery, which is relationship rather than object based. It introduces a new actor into the mix—that of the maker/designer or, semiotically speaking, the author.

The Maker–Wearer–Viewer Model

We borrow the maker–wearer–viewer model from Jack Cunningham's (2005a, 2005b) research. His enquiry revealed the enjoyment felt by wearers of narrative jewellery, which could be experienced as very personal, or be used as a starting point for social interaction. The model brings together three social actors through their narratives—the narrative embodied in a piece by the maker, the extension or evolution of that narrative by the wearer in their dress acts, and the narratives enacted through interaction with viewers. As such, this offers a semiotic model of social becoming through a network of intersubjective meaning-making with material artefacts on the body:

> [T]he narrative object can be ambiguous in its communicative character. It relies on the viewer's subjective interpretation. A dialogue is consequently established between the maker, the originator of the artefacts statement, the wearer, the vehicle by which the work is seen, and the viewer, the audience who thereafter engages with the work…. A triangular relationship is therefore formed between: maker, wearer and viewer. (Cunningham, 2005a, p. VI)

We believe that this is a fundamental departure from mainstream approaches to medical wearable design: how would a wearer of a commercial health monitor begin to think about their "own personal statement" as an expression related to such a device?

Cunningham did not draw this triangular relationship, which leaves open the possibility for playful interrogation of it through diagrammatic representations (Sutton, 2013). Our own working model comprises three bodies in relation within a closed system (See Figure 1).

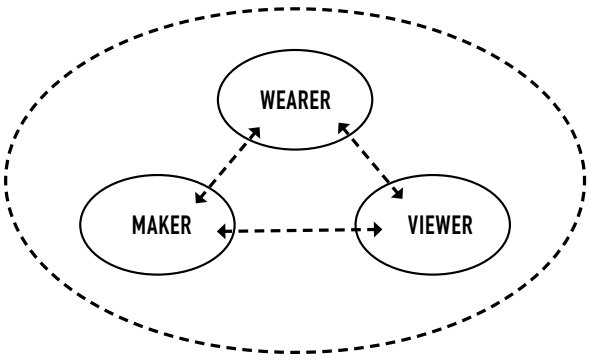

Figure 1. The authors' interpretation of Cunningham's maker–wearer–viewer model.

When we start drawing a literal triangle, we begin to question the flow of semiotic intention—are there other actors to consider? In doing so, we find we can expand on the three actors and develop not only a semiotic but also a phenomenological model that begins to blur the distinction between the actors' roles and identities. Here we describe the maker, wearer, and viewer as actors in the frames of digital jewellery, assistive technology, and wearables development, and point to the literature that might help us develop a holistic model for wearer experience.

The Maker

From a maker's perspective, the accessory approach recognises how cultures of aesthetic consumption involve *authorship* (Kettley, 2007). The maker in this approach may be identifiable as an individual, or, in a more mainstream commercial setting, might be a favoured brand. In Cunningham's (2005b) account of narrative jewellery, the intention of the maker is very important, as it often provides narrative content. In participatory design approaches, the maker role may be blurred, as participants start to create their own versions of technological futures. Beyond this, art, craft and design constitute cultural worlds that are in themselves consumed by individuals as n integral part of identity processes; the skilled creative processes of different kinds of production provide cultural meanings for individuals to identify with, and to use as signifiers of shared cultural belief systems. Making has also come to mean new kinds of attitudes to production, as in the Maker Movement and Slow Design (Dunne, 1999; Hallnäs & Redström, 2002; Boehner, David, Kaye, & Sengers, 2005; Nygaard & Winther, 2016). In this case, we ask what accessory design (which can include jewellers, milliners, shoemakers, fashion and textile designers and hackers, among others), and its materials, bring to the design of future wearable health technology.

The notion of the maker as author has been shown to be important for *authenticity* in the frame of craft theory; in this view, the maker is present in some way to the audience or consumer as an actor who takes responsibility for their material utterances, for their intentions to act, and in their attention to quality (Kettley, 2007). In Cunningham's (2005a, 2005b) terms, we might say that the maker-as-author has something to say, knows what they are talking about, and thinks carefully about how it is expressed.

In reviewing Cunningham's work, Cumming (2004, as cited in Cunningham, 2005b, Ch. 4), said: "This was a show that made you think, not just about the purpose of body adornment but about a potentially vibrant relationship between experience and making." This makes clear the humanity of the maker, their presence as a person, and thus the potential for the wearer, as a person, to also become a maker; it creates a relationship of equals.

The Wearer

A further important aspect of Cunningham's (2005a) model is the explicit "authority to re-interpret the object" (p. VI) that is the right of the wearer, as they "become part of this process of communication with a wider audience, a part of the history of the piece" (p. VI). The wearer does not simply pass on the intentions of the maker, but has a significant opportunity to "make his or her own personal statement" (p. VI), to the extent that even the title of a piece may become less important over time.

The Viewer

From a viewer's perspective, we critically reflect on how a wearer of health technology is seen in society. This is supported by the story of optical lenses, which once stigmatized the wearer, but which we now exploit for their style (Royeen, 2015). Currently,

most wearable device design is influenced by sport, biomechanics or bioengineering (Silina & Hadaddi, 2015). These fields support the technical semiotics of efficiency, achievement and productivity, which may not be congruent for individual wearers. In contrast, we believe the maker–wearer–viewer model supports the complex meaning-making activities individuals engage in every day, but which are sometimes denied to persons with diverse needs in existing biomedical design models (Bush, 2015). We propose that, in such a way, the *social weight* issue (Wallace, 2007) becomes irrelevant, and is replaced by a far more interesting design challenge: to create wearables that are *socially agile*.

The Maker–Wearer–Viewer Model Applied to Medical Accessory Design

With our respective backgrounds in clothing technology, fashion, textiles and contemporary jewellery, we find that the common link in our research is an interest in design for persons who find themselves marginalised rather than enabled by mainstream approaches to assistive technology.

Three projects were selected for critical reflection. The first, *Intimacy in Accessories* (2016) was a one-week teaching project for accessory design students at Design School Kolding, Denmark. The objective was to introduce accessory design students to ethnographic and empathic design methods, to understand the relationship between older women and their three favourite accessories, categorised as jewellery, functional accessory and clothing accessory. The students visited three older women in their own homes, to generate empirical material to enrich the design process of future wearable health technology. The second project, *An Internet of Soft Things*, started in 2014 and continued until the end of August 2016. This was a multidisciplinary project involving computer science, textile design, interaction design, and psychotherapy practice, led by Nottingham Trent University in collaboration with Nottinghamshire Mind Network in the UK. The objective of the project was to develop a design methodology to enable the voices of mental health communities in imaginaries (Lindström & Stahl, 2014) of near future technologies, in this case, the Internet of Things, as enabled by e-textiles. The third, the *Welfare Design Project*, is a design experiment within a PhD project, running from 2015 to 2019 at Design School Kolding. The objective of this work is to coin an accessory way of thinking, to inform the design of future wearable health technology. Together with seven accessory design students and seven women over the age of 61 years, the design experiment facilitated a seven-week design course to analyse design processes and methods for redesigning a medical/clinical health monitor to become a personal object, for older women living in their own homes.

Common to these projects is our urge to investigate how *authorship*, the role of the maker; *phenomenology*, the role of the wearer; and *semiotics*, the role of the viewer, can generate insight in dealing with the crossovers between embodied interaction and semiotic reading of wearable health technologies. Below, we critically reflect on the projects using the model, and explore the model as a tool for such reflection.

Intimacy in Accessories

Three older women (wearers and viewers) engaged in conversations with accessory design students (makers and viewers) in their own homes about their three favourite accessories: a piece of jewellery, a functional accessory, and a clothing accessory. Social interaction fostered close connections between the students, the older women, and the objects. The home settings furthermore promoted anecdotal conversation and served the explorative study with intimate details and rich personal stories. The study generated important information about why the women wore what they did. The approach and method connected social science with design research, to create empirical material. Thus the intention of the project was not to design new wearable objects, but to investigate, from the perspective of designers, anthropological issues and the questions of why older women wear what they do and what constitutes their reasons for their choices.

A consent form explained that it was solely up to the women what stories they wanted to tell. They all signed and agreed to audio recordings being made of the conversations and to having their photos taken.

Authorship (maker)

The study was inspired by *wardrobe studies*, an ethnographic method developed to research dress objects that people favour and consequently keep in their wardrobes for long periods of time (Klepp & Bjerck, 2014). The aim was to map the emotional and relational meanings of the women's accessories, and for the students to understand physical, psychological and social reasons for wearing them. The empirical material from the study was analysed by the author.

In the meetings the students were stunned by how open and willing the women were to share their personal stories with persons they had only recently met. Such insight promotes the students' authorship, as the experience emphasizes their role as makers. The students became reflexively aware not only of the broad category of accessories, but also of the persons they were designing for. The narratives embedded in the jewellery thus became co-authored between wearer and maker, and the normally autonomous role of authorship changed to become more relational, embodying a listening attitude.

Phenomenology (wearer)

The conversational experience between the students and the women fostered reinterpretations of the women's favourite accessories, for both the students and the women. This insight became obvious in the feedback from the women as well as in the students' reflections on the social interactions. There were two linked aspects of felt experience here—the first in the evocative memories for the wearer, supported by the material things, and the second in the research act of transcribing the recorded conversations. Some of the stories included sad or happy characters, which led to different types of astonishment

and enchantment during the conversations between the women and the students. The personal information evoked a sensitive understanding of the women's heartfelt stories.

The students audio-recorded the conversations, and found in transcribing the material that they were sensitized to tone of voice, laughter, and tempo of speech. Listening to the intimate sounds of the recordings made the experience feel "whole" to the listener—to be "tactile" when the women or the accessory design students grasped the accessories to touch or wear them, and "visual" when listening to what happened in the room during the conversations. The study showed that the accessory is an object with unique qualities and personal choice; in focusing on it to reminisce, the wearer was able to communicate embodied memory with the maker/researcher. The objects acted beyond their usual functional and material existence for the wearer and became accessories to felt experience and empathy (Møller & Bang, 2016).

Semiotics (viewer)

Studying and reinterpreting the women's favourite accessories made the students aware of form, value, and meaning. The older women's adornment factors became obvious for the students, and in the meetings the different accessories facilitated relational interactions of expression and function, as part of viewing the women's objects. This led to empathic understanding of the older women's personal preferences and life experiences, and gave the students, as well as the women, insight into their favourite accessories, their choices, and the everyday life of wearable objects.

The accessories discussed in conversation with the makers in Intimacy in Accessories seemed to help the women invoke past lived experience, communicating it with the students to engender empathy (see Figure 2). As a key learning outcome, the method clarifies that the accessory is a representation of the women, who they were, who they are, and who they want to be. This insight gives the accessory unique qualities beyond its functional and material existence. The students' findings and insights resulting from the study are of interest to the wearable health technology community as they discover humanistic factors to take into consideration when designing wearable technologies for older women in particular, and persons with diverse needs in general.

Figure 3 shows the model extended by the addition of the object; it seems that in this project the viewer is implied, while ethnographic practices facilitate an embodied listening process for the maker, who works in collaboration with the wearer according to co-author narratives.

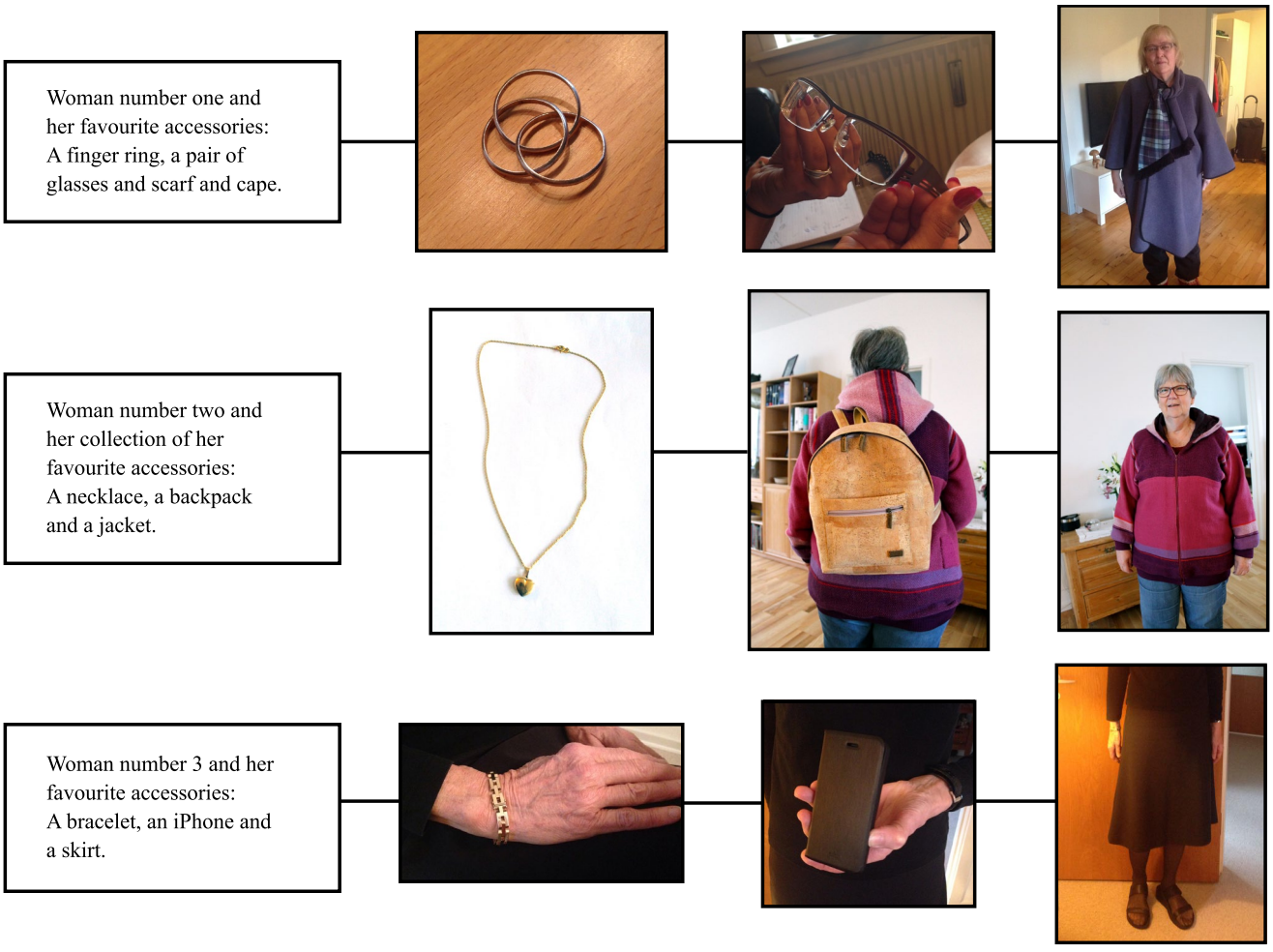

Figure 2. *Intimacy in Accessories*: Three women and their favourite accessories (jewellery, functional, and clothing).

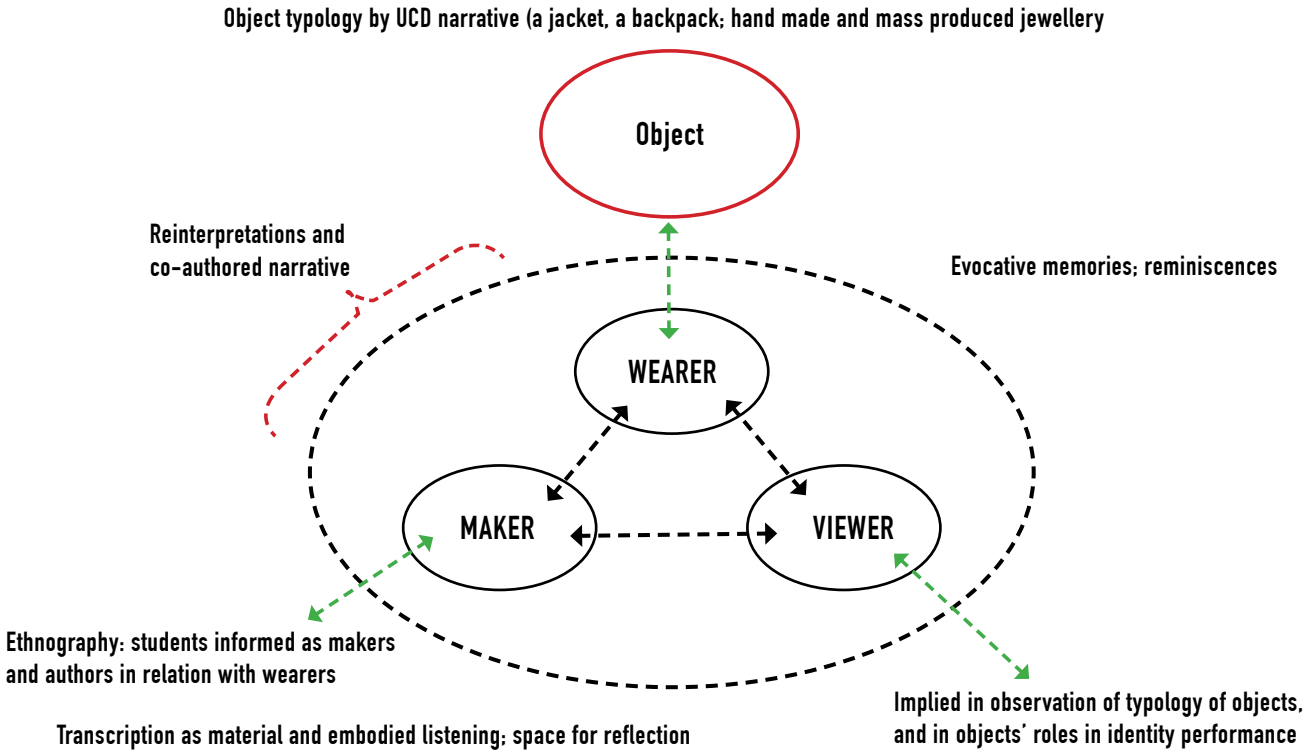

Figure 3. ***Intimacy in Accessories:*** **Visualising with the maker–wearer–viewer model.**

An Internet of Soft Things

An average of six adult participants, male and female, took part in six weekly 3-hour e-textile workshops as part of a longer research project which introduced members and volunteers of the UK third-sector mental health service provider, Mind, to e-textile and Internet of Things technologies (An Internet of Soft Things, 2016). Over the six weeks, individuals learned new skills and reflected on new concepts, and co-created accessories and soft handheld objects with simple LED circuits in them. Each participant received a "toolkit" of parts and materials, along with a booklet of instructions for making simple soft circuits. The participant and trainer booklets can be downloaded at https://aninternetofsoftthings.com/toolkit/. In the second phase of the project, some of the soft objects were networked so that individuals could experience a flow of data and begin devising IoT systems enabled by e-textile interfaces that would be meaningful, and would feel safe for them. The project reflexively appraised the *person-centred approach* (PCA) as a way of doing ethical participatory design (Kettley et al., 2017), and informed consent was granted for the use of these images (in fact, for some participants, this became a positive way of being seen and recognised as persons). A phenomenological methodology was used to collect and analyse qualitative data throughout the project, and a data analytics approach was also used to critically compare methods in big data analysis (Cosma, Brown, Battersby, Kettley, & Kettley, 2017). This article focuses on the experiences of the participants as makers/authors, wearers, and viewers, taking part in the e-textile workshops.

Authorship (maker)

In line with the PCA, the project tried to facilitate the authorship of the participants rather than bring the researchers' authoring to the table (the researchers included makers and textile designers).

Figure 4. ***An Internet of Soft Things*** (Jaimie's work)**: Authorship and making e-textile handheld object.**

If we consider the object and its expression (rather than data or the system), we found that e-textiles offered a context for playful authorship and expression for participants with a range of different life experiences, including careers in the local textile industry, telecommunications, and electronic engineering. We witnessed individuals making choices about fabric, pattern and colour, develop sensitivity towards stitch size and formation (see Figure 6), and collaborating on the form of the textile objects they were making. The research team had brought along large bags of fabrics to the workshops (Kettley, Lucas, & Sadkowska, 2016; An Internet of Soft Things, 2016), and thought some of them were "retro" or "vintage." However, the participants rejected those fabrics as simply old fashioned, embracing the leopard-print fur, and favouring felt and technical spacer fabrics for their strong colours.

In the event, authorship of aesthetics was shared. Pairs formed between the research facilitators and the participants over the six weeks, as trust developed and personalities emerged. Some individuals designed and even drew their own e-textile objects, but felt authorship was diminished if they couldn't sew the pieces themselves (see Figure 4). Others were able to discuss their design decisions as part of a reflective filmed interview (Jones & Fielding, 2015), making associations with well-known public figures (singer Rod Stewart's leopard-print trousers) and favourite foods (an LED on ravioli was lit by a magnet in a patch of brown sauce) (see Figure 5).

Phenomenology (wearer)

As the process evolved, accessories such as hats, scarves, and gloves were introduced, and participants considered how their stitched circuits might be experienced on the body. The group discussed bodily interactions, gestures, and what things felt like to wear.

Josie and Elaine (see Figure 7; real names and images are used by permission) had numerous discussions about what kinds of tactile experiences they preferred. Josie liked the firmness of her earmuffs, which were structured inside with wire—they held her head snugly, and she didn't mind adjusting them to stay comfortable. Having worked in the telecommunications industry, she was happy with hard materials, and didn't like "soft things." Elaine, on the other hand, liked the spacer fabric, which was springy to the touch, and the felt objects filled with stuffing.

One important aspect of the handheld accessories (not garments, but carried in pockets or held) that people made on the project was their tactility and availability for touch. They were described as "touchstones" and their presence became comforting in its own right. Different surfaces, forms and textile sensors were developed in response to individuals' stories about the local town (Worksop, East Midlands, UK) and its associations for them; one participant wanted something she could shake at places she had emotional associations with, while others wanted to squeeze their handheld objects to feel comforted in the moment, or to let someone else know they "were OK." The phenomenological experience with these accessories was thus developed in tandem with emotional expression, whether hidden or overtly expressed.

Figure 5. ***An Internet of Soft Things*** (Chris's work)**: Authorship through personal association and fabric choice.**

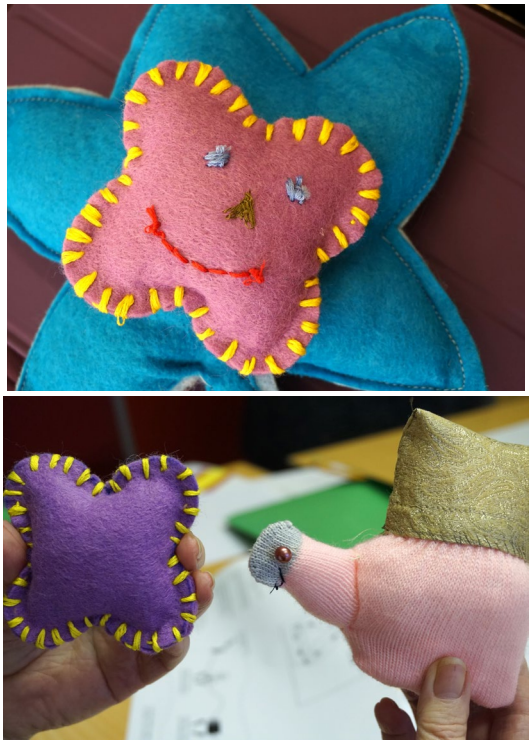

Figure 6. ***An Internet of Soft Things*** (Meg's work)**: Authorship through colourway and stitch choice.**

Figure 7. *An Internet of Soft Things* (Elaine and Josie)**: The felt experience and playful semiotics of wearing.**

Finally, in trying to evidence participant experiences within the workshops, we also used materials, tools, and the made objects to help individuals recall how they had felt in the moment (Jones & Fielding, 2015). The group often talked about the different behaviour of the 2-ply and 4-ply steel yarns when sewing.

Semiotics (viewer)

Wearing an e-textile or "wearable" is quite different to designing it. In a pilot workshop (run before the Mind workshops described above), the researchers felt silly and self-conscious when venturing outside sporting their light-up scarves and hats; accessories for home decoration were easier to assimilate into personal expression. In contrast, participants from Mind thoroughly enjoyed a day trip to a local market town where a Christmas fair was underway, wearing their ear warmers, hats and gloves. Arguably, the time of year had a part to play (see Figure 7).

Some of the maker/wearers also designed worn things or handheld things that were not always visible—they could be held or put into pockets or concealed inside sleeves as required. For these wearers, the "always on" nature of wearables (Rhodes, 1997) could be manipulated; the function may be switched on, but they could modify their intended "body 2" expression as they walked around (Cosma et al., 2017; Goffman, 1990; Ihde, 2001).

The person-centred methodology of this project was successful in creating a context for individuals to become authors, whereas they would normally be more constrained in materials choice and design/meaning-making activities. E-textiles themselves appeared to provide a unique opportunity for both male and female participants, and were inclusive in terms of benefitting from a diverse range of people's professional and crafting experiences. Participants authored with familiar and unfamiliar materials, in response to tactility, colour and function; they brought personal associations and humour into play to create personalised soft things that went on to support their exploration of relationships, their own comfort with their bodies, how they felt they were seen by others, and how they could negotiate the urban area they lived in, while living with diverse experiences of mental ill health. There were some limitations, highlighted by approaching the project through the lens of the maker–wearer–viewer model (see Figure 8). The project blurred the roles of the maker, wearer, and viewer; facilitators and participants viewed each other and themselves, but the objects did not change hands, and were not publicly curated, as in Cunningham's model. It would be interesting to introduce such elements of exchange and framing in the future, which may serve to enhance or even define the roles of maker, wearer, and viewer of e-textile accessories for mental wellbeing.

Welfare Design Project

Seven accessory design students and seven women over the age of 61 years collaborated on redesigning a wearable health monitor. The women decided what information they wanted to share and gave consent to having their photos taken for the research.

To introduce the combination of accessory and welfare design fields, women, and wearable health devices, Professor Jayne Wallace of Northumbria University, UK, was invited to give a talk and teach the students for two days. Wallace's approach treated accessories as objects to think through rather than to study or to produce (2014). Instead, the students (makers) facilitated conversations with the women (wearers and viewers) based on relational wearable objects that they had made beforehand, rather than the students forecasting the women's wants and needs (see Figure 9).

The project continued for seven weeks, starting with an introduction of the method from the *Intimacy in Accessories* (2016) project. In conversation with the women, some of the students studied the women's favourite accessories, as inspiration to redesign the wearable health monitor. The welfare design project was divided into two phases. After the students' research phase (four weeks), they continued their design experiment for three weeks, working on a prototype. Lastly, the redesign was presented to the company behind the existing wearable health monitor, the women, and each other.

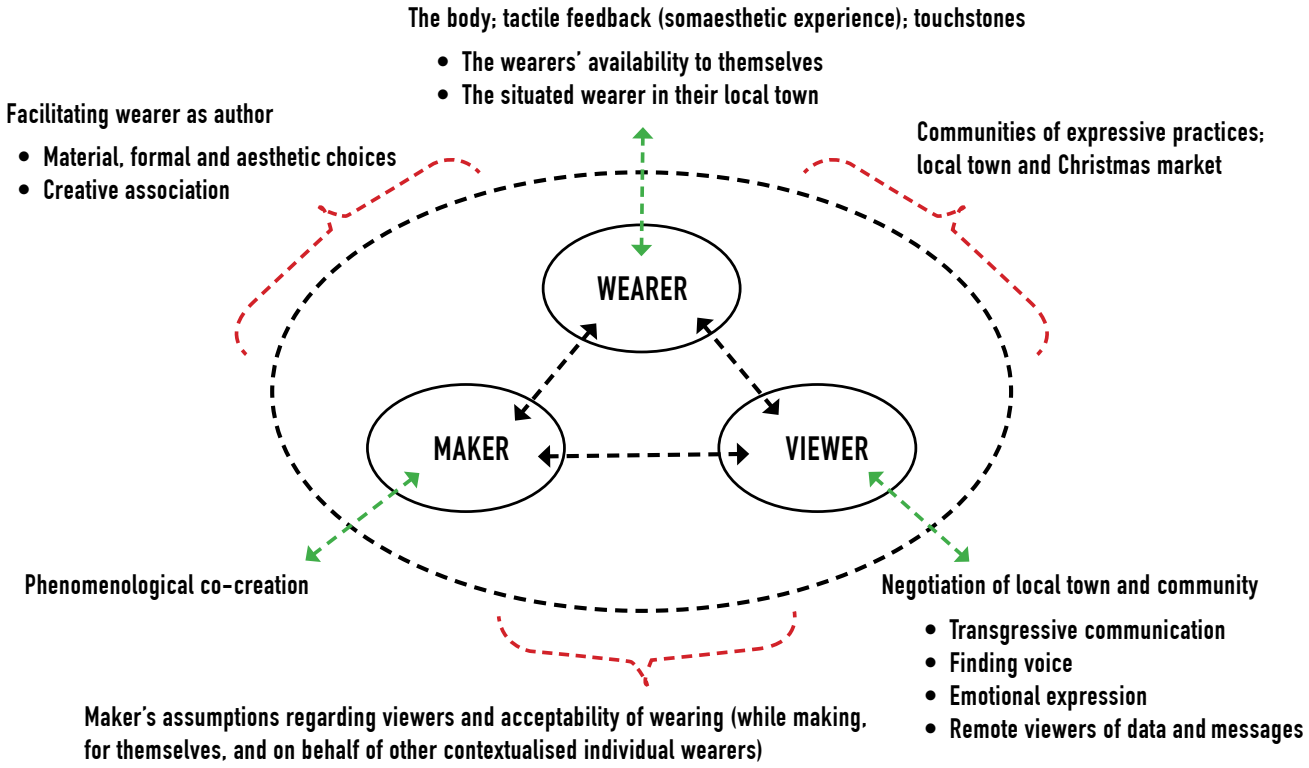

Figure 8. *An Internet of Soft Things:* Visualising with the maker–wearer–viewer model.

Authorship (maker)

Wallace's method focused the explorative study around personal insight and social interaction, rather than focusing on the functionality of the wearable health monitor (see Figure 9). This approach gave a voice to the students as authors of the wearable objects.

Figure 9. *Welfare Design Project*: The students made different relational wearable objects to think and talk through.

The method opened a free channel of conversation, and aligned the relationship between the women and the students—to discuss health, diverse needs and accessory medical design, rather than focusing solely on the expectations of the student or the individual woman. The method naturally drove the students' authorship, fostering their aesthetic preferences, to start ideating and making relational wearable objects as part of their design experiments.

Different from the *Intimacy in Accessories* (2016) project, the students in the *Welfare Design Project* used their design experiments to redesign an object, based on inspiration from the conversations and studies of the women's favourite accessories. Taking part in the first author's PhD project, they documented their processes with diaries reporting their reflections and images taken throughout the project (see Figure 10).

Figure 10. *Welfare Design Project:* One of the students reflects in her diary that working with the women made her design experiment more poetic, as Jayne Wallace's method involved wearable relational objects that easily opened up difficult topics such as death.

Phenomenology (wearer)

The objects became "icebreaker tools" to facilitate personal dialogues based on the women's relationships to the wearable objects, themselves and their health. This gave the students insight into the women's emotional responses beyond the women's reasons for participation. Some of the meetings happened in the homes of the women and this aspect generated another opportunity for the students to reflect on the person, her body and her life environment rather than the technology of the wearable health monitor. The women's wearing and experimenting with the objects made by the students enabled the students to tap into the women's aesthetic preferences and thereby the women's physical experience of the wearable objects. Such involvement benefitted both the women and the students with narratives, beyond the experiential, to communicate unmet needs and the fostering of new ideas. The meetings furthermore created opportunities for collaboration and more involvement of the women as wearers.

Semiotics (viewer)

The relational objects in their wearable state are easy to take and try on the body. Together with the method of investigating the women's favourite accessories (see Figure 11), this naturally started exchanges of meaning-making discussions between the women and the students. In this act, the women's attitudes to adornment were raised, giving the students insights into form and its value, as well as different bodily qualities. Both the relational wearable objects and the chosen favourite accessories became symbols for the women to talk through, and for the students to further explore and reinterpret the design of humanised wearable medical accessories.

Figure 11. *Welfare Design Project:* The women showcased their favourite accessories to the students as part of the research phase.

As a key learning outcome of the project, the two methods involved personal reflections, discussions, and details from both the students and the women. This insight opens up possibilities to put forward humanistic approaches in creative practices when designing wearable health objects. Using the maker–wearer–viewer model (see Figure 12) to reflect on the roles in the project, it is easy to see the company in the wings, and the context of the wearer is domestic rather than urban, contrasting with the *Intimacy in Accessories* and *Soft Things* projects.

Summary of Projects

As in *An Internet of Soft Things*, the *Welfare Design Project* co-designed and facilitated non-judgmental environments, and allowed maker–wearer–viewer relationships to grow based on trust. In all three cases, personal possessions, newly purchased accessories and handmade relational wearable objects became tools for discussion, acting as generators of inspiration and reflection between the maker, the wearer and the viewer. These accessories facilitated conversations of an intimate character—life experiences and personal preferences—to create empathic understanding *in relation with* (and not *of*) individuals. The situations therefore created the necessary contexts for relationships to form, fostering meaningful, useful and desirable design developments.

These unique situations enable further conversations of even deeper understanding of individuals' real life experience, ideas and skills; conversely, participants are enabled to better understand us in the world of (design) research (often the makers), and the technologies being critically handled. However in the other two projects, where participatory and co-design methods were used, these roles became blurred. The role of viewer was assumed to be already somewhat commingled with the wearer role, as accessories as dress acts are understood to be communicative in social groups (Roach-Higgins & Eicher, 1992).

Using the maker–wearer–viewer model to further reflect on each project highlighted some differences in their approaches. The annotated model is most heavily populated for *An Internet of Soft Things*; this is unsurprising as it was a longer and more complex project than the other two at the time of writing. The viewer is most considered in this project, and the wearer's body features as part of individuals' identity and felt experience with the objects. In *Intimacy in Accessories*, the model revealed the power of the objects to carry associations and facilitate reminiscence; they also acted as focal points for the development of strongly relational and embodied psychological contact between the student researchers and the women participants. In the *Welfare Design Project*, the external role of the company is visualised by the model. It further reveals a contrast between the projects, in their contexts for identity enactment: in *Intimacy* and *Soft Things*, the context is shown as being urban, while in *Welfare*, it is more domestic in nature. This may be worth attending to when we assume as researchers that discussion in one environment translates into action in another. Further, in all the projects, the model illustrates how roles became blurred, most often between maker and wearer. We see this as a function of the co-creative and empathetic approaches being developed, but also realise that the viewer is less present in the current research methods. It will be good to take the projects forward with this in mind.

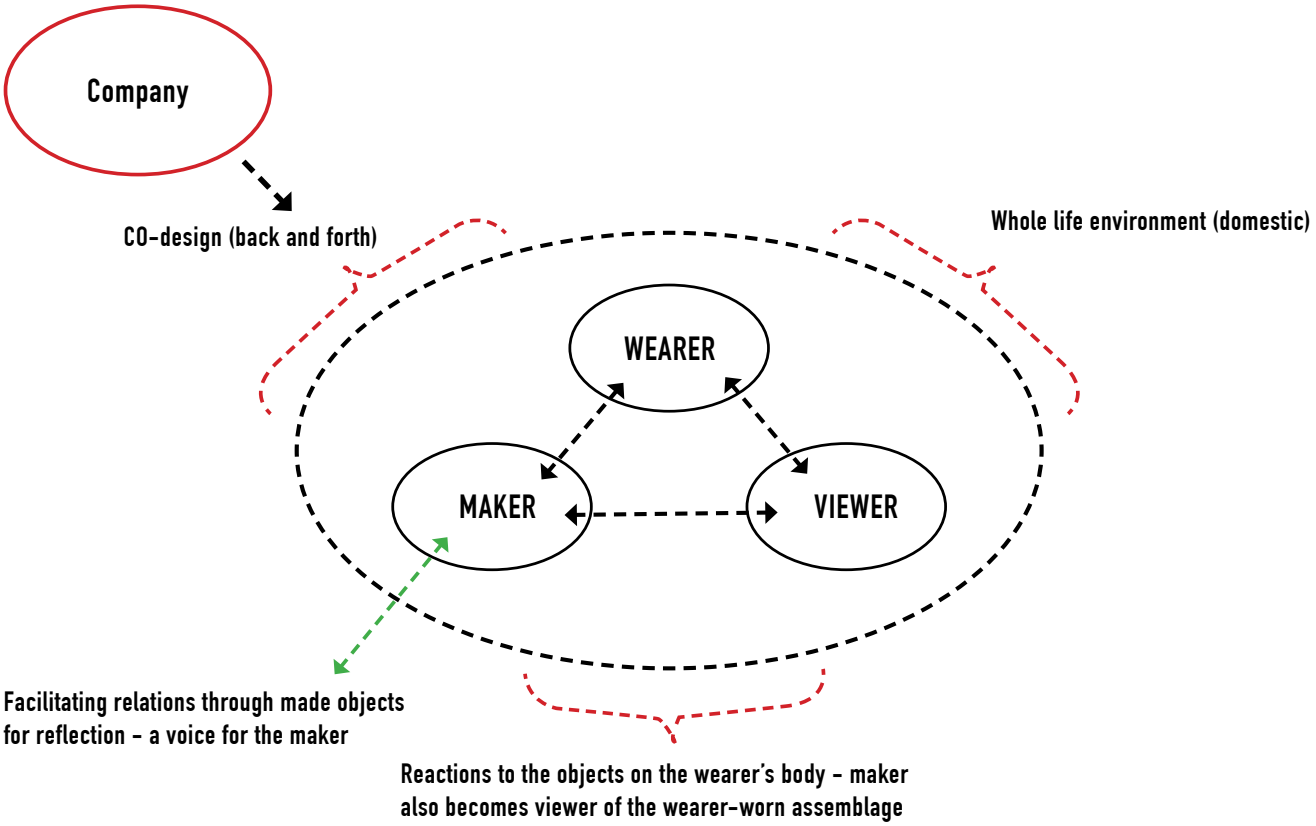

Figure 12. *Welfare Design Project:* Visualising with the maker–wearer–viewer model.

Reflecting on the Maker–Wearer–Viewer Model

Though we are interested in how the accessory acts as an interface between actors, we question the relationship between these actors when designing wearable health technology. To gain insight into our interest we asked the accessory design students from the *Welfare Design Project* to reflect on Cunningham's (2005a) model. From the seven students' visual models, we picked three, shown in Figure 13, to generate our thinking, due to the limited space of the article. Based solely on the three words, and no visual representations or our thoughts about them, the students were asked to reinterpret Cunningham's idea about the social relationships between the maker, wearer, and viewer, with reference to the project of redesigning a medical/clinical health monitor to become a personal object for older women living in their own homes.

Camilla (a) interprets the relationship as a simple circular model, starting with an arrow from the viewer to the maker and then two-way arrows back and forth between the maker and the wearer, and between the wearer and the viewer. This chosen dynamic reflects on how each role may affect the others. In Cecilie's work (b), she has created two triangles as a dynamic background for the model. She uses puzzle pieces to visualize the maker, who is in a meaning-making role, faced with a complex task. The wearer is represented by a clothes hanger, followed by two questions (in Danish): "What would I like to wear?" and "Only function, or aesthetics?" The viewer is shown as a person looking directly at the wearer through a telescope, asking, "How do I perceive the other person?"

The most interesting interpretation, extending the current model, may be Ursula's (c); here the model is created with an extra actor, the object. In a circular diagram she links all four

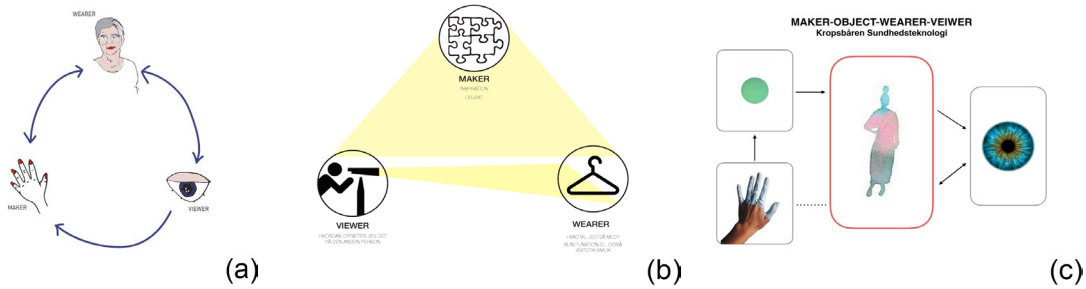

Figure 13. *Accessory design students interpret Cunningham's model*: (a) Camilla (b) Cecilie and (c) Ursula.

parts, to affect each other differently. She illustrates the maker with the representation of a hand, the object as a dot, the wearer in an outline of a feminine body, and the viewer with an eye. She titles the model "Maker, Object, Wearer, Viewer—Wearable Health Technology." Furthermore, in this diagram she has framed the wearer in a red frame, to stand out from the frames of the other elements, the hand, dot and eye. In this case the object is reintroduced not as a fetish at the centre, but as one node in an equal network of meaning creation.

In using the model to visualise the three projects, we also found that different levels of summary, analysis and reflection were possible (here we have shown only one pass at using the model in this way). Like the students, we found we had to extend the model to take into account other stakeholders (such as the company in *Welfare Design*), and the object itself (in *Intimacy in Accessories*).

Concluding Discussion

This paper introduces the previously unexamined nature of the accessory, rooted in body adornment, as a dynamic modifier of relationships between makers, wearers and viewers. When designing future wearable health technology, we suggest a relational design approach that takes into consideration the role of the accessory as an object that affects the wearer physically, psychologically and socially. Through three project studies, the accessory approach was shown to facilitate relationships between makers, wearers and viewers as:

1. A tool for personal reflection, inspiration and discussion;
2. A mediator of intimate conversations, as well as close and trustful human connections;
3. An enabler of insight into a person's life experiences and collaborative ideas;
4. A generator of personal design approaches to understand a person with diverse needs; and
5. A tool for small acts of personal authorship and social agility in the context of large, impersonal systems.

Cunningham's (2005b) proposed model includes a relationship of narratives between the actors. It can be seen as illustrating a somewhat linear evolution of an original narrative, initiated by the maker, modified by the wearer, and interpreted and/or modified by the viewer. At first glance, it offers a relational model in which the object as a design fetish is removed from the role of principal, and in which all actors are equal. The analysis of the projects in the present paper suggests that the model can be extended to take account of the embodied experience of the maker and the wearer with materials, by reintroducing the object, but this time in an equal relational arrangement in which there are no fixed principals (masters) or accessories (slaves), only multiple actors in dynamic interplay. We conceptualise this as the *accessory platform* or *accessory approach*, which facilitates expressive social agility rather than fearing social weight in the design of medical health technologies to be worn on the body.

Acknowledgments

We would like to thank the Erasmus+ Programme, Anne Louise Bang, and Nottingham Trent University for making the authors' collaboration possible. A big "thank you" to the accessory design students and Head of Accessory Design, Josephine Winther, at Design School Kolding for playing along. None of the projects would have been possible without the generosity of the participants in Denmark and at Bassetlaw Mind, Nottinghamshire—thank you to everyone. The *Internet of Soft Things* project was supported by a Research-in-the-Wild grant from the Engineering and Physical Sciences Research Council (EPSRC), UK, reference: EP/L023601/1.

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